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Influence of the Weight of Mini Corm Fragments on the Rejection Power of Plantain (Musa sapientum L.) Ex-Situ at Gbadolite in the Democratic Republic of Congo

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Abstract: *This study tested the influence of bulb fragments on the rejection potential of plantain ex-situ. The experimental set-up chosen was that of randomized complete blocks comprising 4 blocks and 4 treatments according to the weights of the minisets. Treatments were assigned to line plots under ex-situ conditions. They were made up of the following fragments: T0 (20g fragment), T1 (5g fragment), T2 (10g fragment), and T3 (15g fragment) at a rate of 150 minisets per treatment installed on a propagator in a greenhouse. For each bulb, 4, 17, 18 and 21 rejections were counted, respectively, for the control: T1 (5g fragment), T2 (10g fragment), T3 (15g fragment) and T0 (20g fragment). In the event of a shortage of planting material, the bulb can be cut into mini-pieces of around 10g, i.e., 2/4 of a bulb, in order to increase the rejection potential and thus produce planting material.*
Keywords: *fragments; bulb; reject; Gbadolite; Democratic Republic of Congo*

I. Introduction

Bananas are of vital importance to the world's diet (Bezard et al., 2023). As for plantain, it is a staple food for many people in Central Africa in general and in the Democratic Republic of Congo in particular. Plantain is generally consumed after cooking and plays an important role in the social structure of many rural communities, as, in most cases, it becomes the sole source of income (Dhed'a et al., 2019; Bangata et al., 2023).

However, the availability of healthy planting material in sufficient quantities is a crucial problem. Offshoots are often not physiologically homogeneous and are frequently contaminated by black weevils and nematodes (Sadom et al., 2010; Kone et al., 2011).

The rapid production of planting material is one of the main concerns of many banana research programs. Various vegetative propagation techniques have been developed in vitro to produce massive quantities of plants: micropropagation from meristems grown in agar or liquid media, somatic embryogenesis, and embryogenic cell suspensions (Kwa, 2003).

However, despite the success of these methods for multiplying banana plants used in industrial plantations, these in vitro techniques are not suitable for small-scale producers in southern countries, who are regularly faced with the problem of the availability of cuttings to create, replant or extend their banana plantations. A few in vivo nursery propagation techniques have made it possible to increase the rate of banana multiplication in the field. On the other hand, the production period for offshoots is long: it can take six to twelve months to obtain planting material. What is more, many buds formed on the mother plant remain unexploited (Lasourdière, 2007; Lyadunga et al., 2020; Molongo, 2022).

Among the techniques used in situ are pseudo-stem bending, decapitations, of which false decapitation gave the best results, producing between 6 and 10 shoots per plant, and the bulb bursting technique. There are also forms of propagation used in vivo under horticultural soilless conditions, notably the miniset technique (Dhed'a et al., 2019).

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To reduce these problems and optimize the exploitation of the banana's rejection potential, a new rapid multiplication technique has been developed by the Centre Africain de Recherches sur Bananiers et Plantains in Cameroon. It is called the PIF technique and is based on the use of planting material derived from stem fragments. The use of banana stem fragments makes it possible to activate latent buds to regenerate large quantities of healthy plants in relatively short timescales that can be adjusted to planting periods (Kwa & Temple, 2019).

In view of the above, this study has answered the question as to whether the use of bulb fragments or mini sets can produce enough offsets ex-situ for field planting. From this question, it would appear that the fragment would be capable of supplying the rejects under the conditions of Gbadolite in the Democratic Republic of Congo. The overall aim of this study was to assess the influence of mini-fragments on the potential for ex-situ rejection.

II. Review of Literature

2.1. Environment

The present study was carried out in Gbadolite, in the province of Nord-Ubangi, in the Democratic Republic of Congo, at the Plateau des Professeurs of the University of Gbadolite in the Pangoma district in the commune of Gbadolite. According to GPS, the geographical coordinates of the site are as follows: 4°15'44" Latitude North and 20° 59 5’” Longitude East with an altitude of 394.7 m.

The relief of the town of Gbadolite is made up of plateaus, hills and plains, and the climate is of the Aw_2 type according to Köppen's classification (FACET, 2010). The soil is clayey-sandy, rainfall is relatively abundant with an annual average of over 1,600 mm, and insolation is low, representing 45% of total tropical energy radiation (Molongo et al., 2015). The direct solar radiation intensity is 25 g calorie/cm^2/minutes (Molongo et al., 2019).

The vegetation in the town of Gbado-lite used to be evergreen equatorial rainforest. However, as a result of the anthropogenic effects exerted on this forest, the vegetation has been reshaped by savannah dominated by *Imperata cylindrica, Pennisetum sp, Chromolaena odorata, Pannicum maximum and Mimosa pudica* (Molongo et al., 2022).

2.2 Materials

The planting material used in this study was that of a traditional cultivar, Yongo (French type), according to the local name (Figure 1).

Figure 1. *Yongo cultivar (French type)*

2.2 Method

The shoots were taken from mother plants in farmers' fields following macroscopic analysis and selection. They were trimmed, stripped and shelled. The stem explants thus produced according to treatments were dried for 48 hours under a shade canopy, in the open air, in a dry place before sowing (Ngo-Samnick, 2011).

The experimental set-up chosen was that of randomized complete blocks comprising 4 blocks and 4 treatments according to the weights of the minisets. Treatments were assigned to plots in rows under *ex-situ* conditions. Treatments were made up of the following minisets: T0: 20 g; T1: 5 g or ¼ of a bulb; T2: 10 g or 2/4 of a bulb and T3; 15 g or ¾ of a bulb at a rate of 10 minisets per treatment installed on a propagator in a greenhouse, the shoots were weaned as shown in figure 2.

Figure 2. *The propagator*

The greenhouse temperature varied between 24 and 48°C during the day and between 24 and 27°C at night for 3 months of experimentation.

Observations were made on the following parameters: Day at 50% rejection and weaning in days; height of rejection weaned using the tape measure; diameter of cormus of rejection weaned by caliper, leaf area using the following formula $SF\ (en\ cm\ carré) = \frac{\text{Longueur de feuille x largeur de feuille}}{2}$ and the number of shoots formed per corm by counting.

The data from this research were analyzed using *SPSS Statistics* IBM 20 software. The single-criterion Analysis of Variance classification without sampling and the Snedecort F test was used to identify the significant difference between treatments; the Tukey test was adopted to group treatments according to the power of rejection between treatments (Spiegel, 1992).

III. Results and Discussion

3.1 Trade-in Rate

The recovery rate is shown in Figure 3.

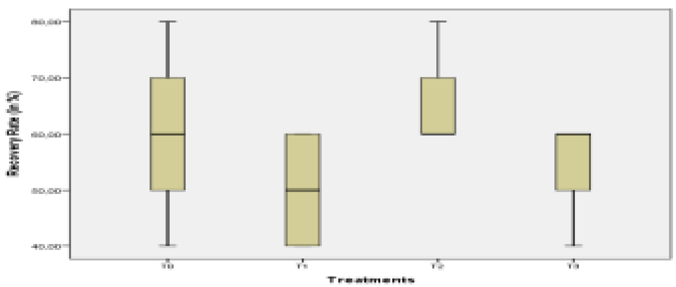

Figure 3. *Trade-in rate (in %)*

This study shows that the recovery rate recorded varied between 50% (T1 or 5 g fragment) and 65% (T0 or 20 g fragment) under greenhouse conditions. The coefficient of variation was less than 30%, which means that recovery was homogeneous. The low rate during this recovery is justified by banana weevil infestation and other environmental causes. The analysis showed that there was no significant difference between treatments.

3.2 Height of Weanlings

The height was taken, and the result was recorded in Figure 4.

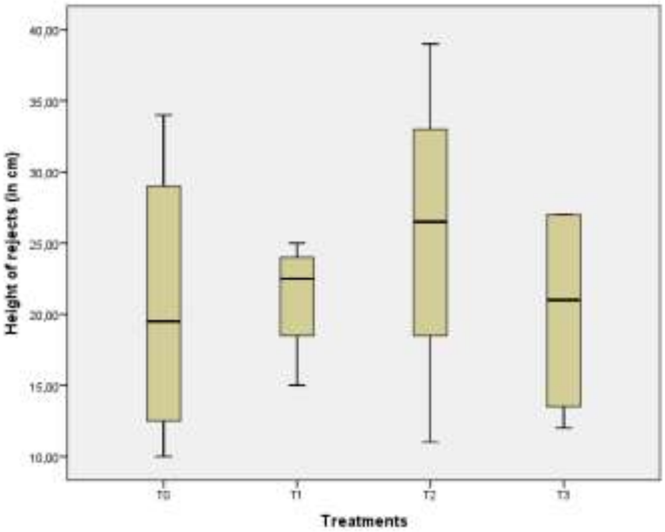

Figure 4. *Height of weaned rejects*

In this study, weaned shoots were found to vary in height from 20.2 cm to 25.7 cm. Miniset offspring were found to be similar in height to controls. This is justified by the fact that the fragments have a reserve of energy capable of producing plants as tall as those from unfragmented bulbs. Statistical analysis showed that there was no significant difference between treatments. The coefficient of variation was heterogeneous between controls and minisets.

3.3 Number of Leaves at Weaning

The number of leaves was counted, and the results are shown in Figure 5.

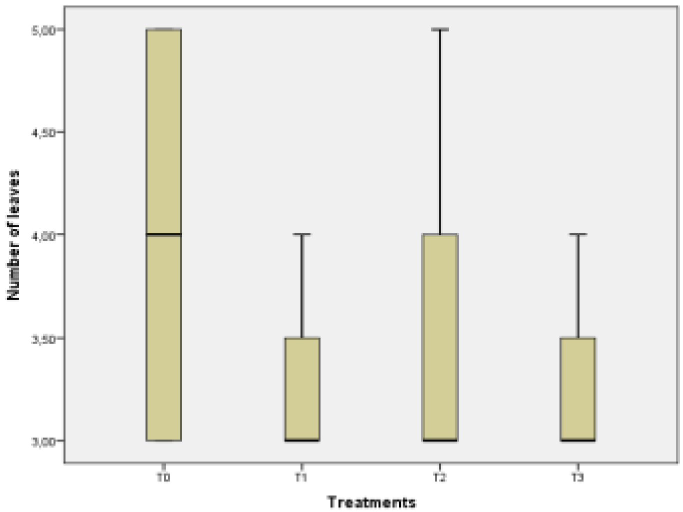

Figure 5. *Number of leaves at weaning*

The figure shows that the number of leaves of weaned subjects varied between 3 and 4 during this study. The analysis confirmed that there was no significant difference between these treatments. In other words, whatever the size of the propagation material, it ends up giving subjects with the same number of leaves.

3.4 Corm Diameter of Weanlings

The corm dimensions are shown in Figure 6.

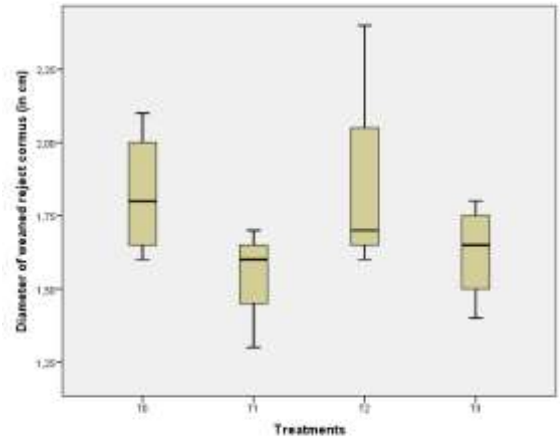

Figure 6. *Corm diameter of weanlings*

The results in Figure 6 show that corm diameters ranged from 1.2 cm to 1.4 cm. The subjects with the smallest sprouts were those from 5 g minisets. Analysis showed that there was no significant difference between these treatments.

3.5 Leaf area (in cm^2)

The leaf area was calculated, and the results are shown in Figure 7.

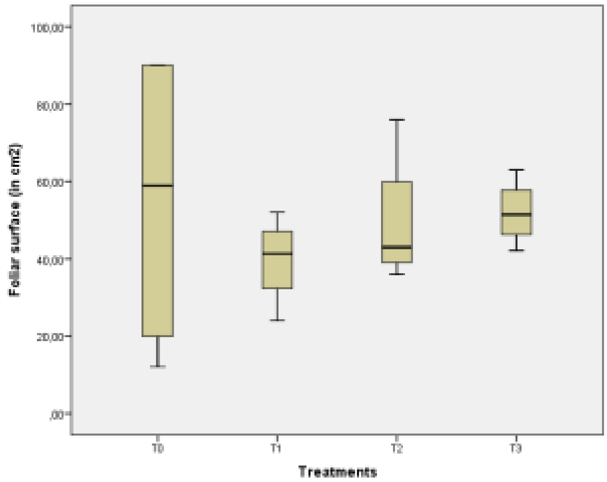

Figure 7. *Leaf area (in cm^2)*

The results, as shown in Figure 8, show that the subjects with the largest leaf area are those from 20 g bulbs, i.e., control plants.

3.6 Number of Shoots per Bulb

The number of weaned releases was recorded in Figure 8.

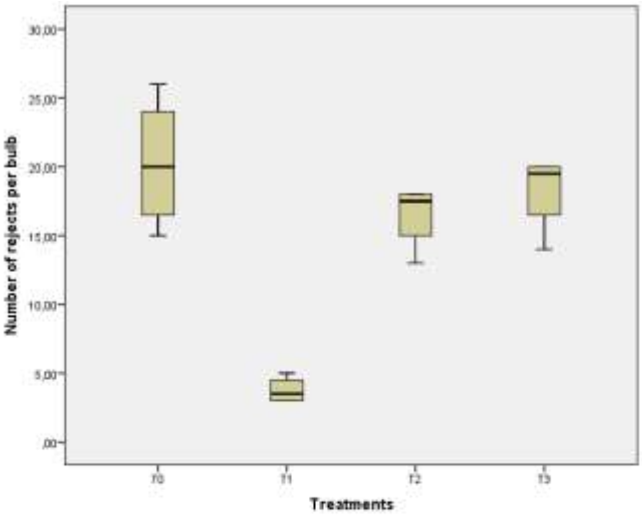

Figure 8. *Number of shoots per bulb*

Per bulb, 4, 17, 18 and 21 shoots were counted during this investigation, respectively, for minisets weighing 5g (T1), 10g (T2), 15g (T3) and 20g (T0). The number of offshoots was proportional to bulb weight, thanks to the bulb's food reserves, which promote the growth and development of offshoots. A small bulb with low food reserves is detrimental to the plantain bulb's potential for sprouting.

3.7 Discussion

The present study aims to observe the influence of bulb fragment weight on the rejection capacity of plantain *ex-situ, with a* view to overcoming the bottleneck in obtaining plantain planting material in farming environments.

The recovery rate during this study could have been better in low-weight, 5g (T1) minisets due to insufficient food reserves capable of contributing to reject growth. The recovery rate in this study was lower than the 82.5% and 90% observed by Bangata et al. (2018).

It was observed that weaned shoots ranged in height from 20.2 cm to 25.7 cm, with heights in the 14.50 cm and 33.22 cm range, respectively, for shoots steamed at 100°C for 10' and those steamed at 80°C for 1 minute (Molongo et al., 2023), a situation justified by the heat stimulation of this parameter.

The number of leaves on weaned plants varied between 3 and 4 during the study. The number of leaves at weaning was between 3 and 5 per shoot, which were transplanted into polyethylene bags filled with potting soil and sawdust, watered and installed in a hardener before moving on to the nursery to alleviate stress and initiate rhizogenesis. Thanks to the root-leaf synergy, these leaves are able to lead independent lives. This situation corroborates that of Kwa (2003), according to whom weaning took place around 3 to 6 weeks later, when the plants formed had between three and five leaves.

Corm diameter is between 1.2 cm and 1.4 cm, less than 2 and 3.3 cm (Bangata et al., 2018). In this study, it was between 1.4 and 2.4 cm, as observed by Bangata et al. (2019); this situation is justified by the fact that the explants are of small size or weight.

In the course of this study, 4 (T1 or 5g fragment), 17 (T2 or 10g fragment), 18 (T3 or 15g fragment) and 21 (T0 or 20g fragment) shoots per bulb were counted using bulb fragmentation; a rate higher than 1 and 3 shoots per plant under peasant growing conditions; and 4 and 8 shoots per plant on average after application of false decapitation (Lassourdière, 2007). Apart from the controls, which produced 21 shoots per bulb, our results are lower than 20 and over 100 seedlings depending on the variety and level of PIF technical mastery (Kwa, 2003); buckling and steaming in relation to the temperature and steaming time pair (Molongo et al., 2015; Molongo et al., 2023) but higher than 3 and 5 shoots per mother plant obtained in the field after 13 to 18 months in traditional conditions (Boye et al., 2017). The upper end of production of treated rejects was higher than 11 and 17 obtained by Koné et al. (2011).

We also note that the number of shoots produced evolves in the same direction as development parameters. This may be due to a correlation between the nutrient reserves present in the rhizome and the buds' need for development and growth (Kone et al., 2011).

The analysis of variance and Snedecor test showed a significant difference between treatments; the Tukey test grouped treatments as follows: T1, T2, T3, and T0. In other words, the best treatment in this study was T0 (20 g fragment), which was no different in terms of rejection potential from T3 (15 g fragment) and T2 (10 g fragment); however, these were different from T1 (5 g fragment).

IV. Conclusion

The present study observed the effect of mini-fragment on the rejection potential of plantain ex-situ. In addition to the 20 g fragment controls, which produced 21 shoots per bulb, the results suggest that the fragments produced 4, 17 and 18 shoots per bulb, respectively, for T1 (5 g fragment), T2 (10 g fragment) and T3 (15 g fragment). It is, therefore, possible to circumvent this shortage by fragmenting bulbs when few shoots are available in order to increase the plantain's rejection capacity.

Since banana is such an important crop, the response of this technique to different local substrates needs to be verified.

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